Summary.

Consideration of the rates of expansion of the two ring-boundaries surrounding Nova Persei, as shown in Ritchey's drawings (*Ap. J.*, **15**, 1902), suggests that they represent spherical surfaces concentric with the Nova. If it may be presumed that they cannot be *prolate* spheroids, we are led at once to a very definite value for the scale of the phenomena and to sensible sphericity for both surfaces. The parallax assigned for the Nova is

$0''{\cdot}0093$ (350 light years).

It is further suggested (in line with the ideas outlined in *M.N.*, 72, p. 405) that the phenomena of the Nova were the result of a gravitational contraction of a portion of the surrounding nebula (which is disposed in nearly spherical layers, modified in one direction by tidal arms), which was very rapid in its final stages, leading to the outburst by congestion.

On the Spectrum of Nova Aquilæ (1918) *on* 1918 *June* 13 *and* 15.

By H. F. Newall, Professor of Astrophysics, Cambridge.

Amongst the photographs of the spectrum of Nova Aquilæ (1918) secured at the Solar Physics Observatory, Cambridge, two of those obtained on 1918 June 13 and 15 have been measured and studied with special reference to the numerous absorption lines which are seen in the spectral region $\lambda 4000$–$\lambda 5000$.

There are some points of interest which seem to justify my laying them at once before the Society.

Each photograph has a comparison spectrum of an iron spark imposed close to the stellar spectrum. The scale of dispersion is such that the distance between H_β and H_δ is 29 mm.

The Emission Bands of Hydrogen of Nova Aquilæ.

In the photograph *d*, June 13, in the series each of the emission bands of H_δ, H_γ, H_β may be described as a bright band exhibiting four maxima. Two of them, being close together and somewhat difficult to measure separately, have been bisected as a single group, which forms the brightest part of the whole band near its middle point, and, as a single group, give displacements corresponding to a mean velocity -110 km./sec.

The other two are situated approximately symmetrically on either side of the central group; they have displacements corresponding to velocities -1314 and $+1200$ km./sec.

In the photograph *g*, June 15, of the series each of the emission bands of H_δ, H_γ, and H_β has three maxima, one central and two lateral, one on either side of the central maximum. The central

maximum here appears to be a single broad maximum. The two lateral maxima are more sharply marked than those in photograph *d*, June 13, and they have displacements of the same order of magnitude as the lateral maxima of photograph *d*, June 13.

The Displaced Absorption Lines of Hydrogen of Nova Aquilæ.

The absorption phenomena of these hydrogen lines on the violet side of the emission bands are strongly marked. The dark lines appear in a continuous spectrum which is intermediate in intensity between the emission bands and the continuous spectrum in other regions of the spectrum, where it is free from superimposed emission bands due to the enhanced lines of iron and other elements.

In photograph *d* of June 13 two marked absorption lines appear with homologous relations in the lines H_δ, H_γ, H_β, and may be described as consisting of two quite distinct parts, one very broad and highly displaced to the violet, the other narrower and less displaced to the violet.

In photograph *g* of June 13 there are three marked absorption lines with homologous relations in the lines H_δ, H_γ, H_β. Comparison of the photographs *d* and *g* suggest the idea that the broader line of June 13 might be fairly regarded as a blend of two broadish lines which on June 15 had become separated into two distinctly separated lines.

The results of measurements are summarised in Table I.

TABLE I.

Absorption Lines of Hydrogen Displacement.

		Width in A.U.	Δλ. Obs.	Δλ. Calc.	Km./sec.	Width in A.U.	Δλ. Obs.	Δλ. Calc.	Km./sec.	Width in A.U.	Δλ. Obs.	Δλ. Calc.	Km./se
d, June 13.	H_δ					5·5	−33·0		−2412	2·7	−22·1	−22·6	−161
	H_γ					6·7	−35·4		−2446	4·6 ?	−23·8	−23·9	−164
	H_β					8·7	−40·2		−2480	3·7	−27·6	−26·8	−170
				Mean					−2446				−165
g, June 15.	H_δ	1·8	−37·5	−38·3	−2741	1·2	−31·1	−31·3	−2273	2·5	−22·9	−23·1	−167
	H_γ	?	−41·5	−40·5	−2867	1·7	−33·0	−33·1	−2280	2·7	−24·3	−24·4	−167
	H_β	?	−45·1	−45·3	−2782		−37·6	−37·1	−2319	?	−27·9	−27·4	−172
				Mean	−2797				−2291				−169

Previous experience in the study of the spectra of Nova Persei (1901) and of Nova Geminorum No. 2 (1912) made me desire to test the view that the narrow absorption lines in the early spectrum of Nova Aquila are in the main ascribable to the superposition of two or even three displaced spectra, each of the type of α Cygni. The peculiar variation in the relative intensities of the narrow absorption lines in successive photographs of the early spectra of Novæ reminded me strongly of my experience in sorting out the

superimposed spectra in the binary α Aurigæ. That experience had shown that when one spectrum of many lines is periodically displaced over another similar spectrum, there arise surprising recurrent effects of both intensification and weakening or even obliteration of lines by reason of an effect which may be tersely described as a "palisade" effect, the name being suggested by the appearances seen when one looks from a distance at two palings one behind the other.

In a note* presented to the Society on the early spectrum of Nova Geminorum No. 2, it was pointed out that the lines of the Nova coincided in large measure with lines characteristic of α Cygni, if the latter spectrum were shifted to the violet with a displacement corresponding to a velocity of about 700^{km}/sec., and it was suggested that possibly a fuller coincidence would be obtained between the lines of the Nova and the displaced lines of a spectrum intermediate between α Cygni and γ Cygni.

In the study of the spectrum of Nova Aquilæ it appeared to me that the palisade effect in two or three relatively displaced spectra of α Cygni would reproduce all the absorption lines in Nova Aquilæ.

First the wave-lengths of the narrow lines in the Nova spectra for June 13 (d) and 15 (g) were determined, and the displaced absorption lines of hydrogen were first dealt with.

The values of λ'/λ were computed for each of the homologous lines in H_δ, H_γ, and H_β, where λ' is the displaced wave-length and λ the normal wave-length. These were found to be approximately constant, and thus it would appear that an interpretation of the displacements by reference to a velocity effect is justifiable, as was found by Campbell and Wright in the case of the smaller displacement observed in the spectrum of Nova Persei (*L.O.B.*, i. 49).

The following table illustrates the results for the two photographs measured:—

Table II.

	Photograph d, June 13.		Photograph g, June 15.		
	$\frac{\lambda''}{\lambda}$	$\frac{\lambda'}{\lambda}$	$\frac{\lambda'''}{\lambda}$	$\frac{\lambda''}{\lambda}$	$\frac{\lambda'}{\lambda}$
H_δ	·99196	·99461	·99087	·99243	·99441
H_γ	185	450	043	259	440
H_β	174	432	072	225	426
Mean	·99185	·99448	·99067	·99236	·99436

The displacements of the absorption lines, $\lambda' - \lambda$, if they are proportional to the normal wave-lengths, are thus

$$\lambda' - = (\text{mean factor} - 1).$$

The values deduced from the mean factors of Table II. are entered in Table I. in the column headed "Calc."

* Newall and Stratton, *M.N.*, **73**, 380.

The Narrow Absorption Lines of Nova Aquilæ.

The absorption lines in the Nova between H_β and H_δ were measured as completely as possible, and their wave-lengths were determined.

Next the lines in a spectrum of α Cygni, photographed with the same spectrograph, were measured, only such being picked out (to the number of 41) as were within the same range of intensities as had been measured in the Nova, and their wave-lengths were determined.

It was at once seen that the principal narrow lines of the Nova spectrum obviously coincided in many respects with α Cygni lines when these latter were displaced by amounts equivalent to the displacements of the strong absorption lines of hydrogen. In fact, if a spectrum is built up synthetically of two spectra of α Cygni, displaced from the normal in a manner similar to the displacements of the duplicate absorption lines of hydrogen in the Nova of June 13, the correspondence with the Nova is fairly complete, with all its curious vagaries in emphasis on some lines and want of emphasis on others.

In the synthetic compounding of the spectra the displaced wave-length of each line in α Cygni was computed by multiplying the normal wave-length by factors which are the means given in Table II. Thus an α Cygni line of normal wave-length 4481·3 gives two displaced lines of wave-lengths $4481{\cdot}3 \times 0{\cdot}99185$ and $4481{\cdot}3 \times 0{\cdot}99448$; that is, of wave-lengths 4444·8 and 4456·6.

This procedure being carried out for each of the α Cygni lines, the two displaced spectra can be graphically combined to form a single synthetic spectrum to be compared with that of Nova Aquilæ on June 13. The comparison instituted shows satisfactory agreement, when account is taken of the palisade effect, which results in apparent intensification of certain lines, when, for instance, a chromium line with the smaller displacement falls on a titanium line with the larger displacement. An apparent weakening or even obliteration of lines takes place when a group of lines with the smaller displacement is out of step with the same group with the higher displacement.

In the photograph of June 13 (*d*), 50 absorption lines were measured. Out of these 38 have been clearly interpreted as α Cygni lines displaced, and 27 are connected with what may be called an α Cygni absorption with displacement corresponding to the velocity, −1654 km./sec., and 17 are connected with an α Cygni absorption with displacement corresponding to the velocity, −2446 km./sec. On examination of the 12(=50−38) lines which were not identified as ascribable to any of the lines actually measured by me in α Cygni, 6 have been found to be ascribable to α Cygni lines, well-known enhanced lines, but not measured by me in the α Cygni photograph.

In the case of Nova Aquilæ on June 15, when the narrow absorption lines are less accentuated, comparison is instituted

between the Nova and a triple synthetic α Cygni spectrum, based on the three displacements of the hydrogen lines.

In the photograph of June 15 (g), 28 lines were measured; they are markedly less well defined and more difficult to measure than in the earlier plate. But 17 of them are interpreted as α Cygni lines, 8 being ascribed to the highest velocity, -2797 km./sec., 7 to the intermediate velocity, -2291 km./sec., and 9 to the lower velocity, -1691 km./sec.

In the latter photograph (g) an interesting case of obliteration of line absorption is to be seen between $\lambda 4426 \cdot 7$ and $\lambda 4445 \cdot 7$, a region which was noted as being a region of general reduction in the intensity of the spectrum of the Nova. In this region there are three α Cygni lines, which when superposed with the three hypothetical displacements would give a series of 9 lines so evenly spaced as to produce an obliteration.

In the same photograph (g) there is, however, a group of 8 nebulous lines in the region of $\lambda 4558$ to $\lambda 4619$, which I am at a loss to interpret.

Two interesting cases which at first sight seemed to throw weight against the view here suggested may be cited as giving confirmatory evidence in support of the view. One relates to the photograph of June 13, the other to the photograph of June 15. In the first it appeared that the very marked line corresponding with the displaced enhanced lines of iron at $\lambda 4233$ was single, but on re-examination of the photograph it was found that two lines are present, one as a narrow and strongly marked line with a displacement corresponding with the less displaced lines of hydrogen, and the other as a broad diffuse line with a displacement corresponding with the more displaced and broader absorption lines of hydrogen.

In the photograph g of June 15 the displaced absorption lines at H_γ seemed to be fourfold, but one of them has no homologous line in H_δ and H_β. On re-examination of the computed displacements of α Cygni lines for that date, the apparent fourth component in H_γ was found to coincide with a displaced enhanced line of chromium at normal wave-length 4351, which makes its appearance between the two least displaced H_γ lines.

Conclusion.

The result of this examination leads me to believe that the hypothesis which it was desired to test is supported by the evidence extracted from the photographs which have been measured and studied. The conclusion arrived at is that narrow absorption lines in the spectrum of Nova Aquilæ on June 13 are absorption effects similar to those characteristic of α Cygni, when duplicated by two displacements corresponding with those of the absorption lines of hydrogen in the Nova.

Note.—A plate illustrating the paper is being prepared for reproduction, but is, unfortunately, not ready for the present number.

Solar Physics Observatory, Cambridge:
1918 *November* 6.

Magnitudes of Nova Aquilæ, 1918, *deduced from Photographs taken at the Royal Observatory, Greenwich.* By H. P. Hollis.

(*Communicated by the Astronomer Royal.*)

The new star in Aquila was seen at Greenwich on the nights of June 8 and 9. The first photograph from which a magnitude can be determined was taken on June 10. Since that date photographs have been taken with stars near it in position and of approximately the same magnitude for comparison on suitable nights, and the magnitudes determined from these are given in the Table which follows.

The photographs were taken with the Astrographic Equatorial, the object glass being stopped to 6 inches aperture, on Ilford Empress Plates. The stars were photographed on the same plate, each with a series of exposures differing in length, the same for each star, the exposures on the Nova being intermediate in time to those on the comparison stars. The magnitudes here given are deduced generally from exposures of 30 secs., 20 secs., 15 secs., and 10 secs. to the end of July, and of 80 secs., 40 secs., 20 secs., and 10 secs. for the later dates. The diameters of the images were measured in the duplex micrometer at first by means of the scale in the eyepiece, and from August 13 with a small micrometer mounted on the measuring machine for the purpose. From these measures of diameter, the magnitudes of the Nova have been deduced by interpolation, the magnitude of the comparison stars being taken in the first instance from the list of Standard Photographic Magnitudes of Bright Stars in *Harvard Annals*, **71**, 17, 18, and the formula, magnitude $= c - k\sqrt{\text{diam.}}$ being used. Corrections for atmospheric absorption were used in the course of the work, taken from Schwarzschild's *Aktinometrie der Stern der B.D. bis zur Grosse* 7·5, the table there given being extended to lower altitudes empirically.

ZD.	45°·5	51°·1	57°·5	63°·5
Correction	0·32	0·33	0·48	0·75 mag.

From the measured diameters of the comparison stars a determination of their relative magnitude was deduced, which depends necessarily on the value of the absorption corrections for the lower stars. A list of the comparison stars, with these magnitudes which were used as standard, is given here.

	Adopted Magnitude.	Harvard Photographic Magnitude.		Adopted Magnitude.	Harvard Photographic Magnitude.
α Lyræ	0·11	0·11	β Ophiuchi	3·97	4·11
α Aquilæ	1·07	1·07	γ Aquilæ	4·40	4·22
α Cygni	1·37	1·37	η Serpentis	4·41	4·66
α Ophiuchi	2·39	2·35	β Aquilæ	4·81	4·96
ζ Aquilæ	3·04	3·03	12 Aquilæ	5·32	5·25
θ Aquilæ	3·67	3·29	64 Serpentis	5·59	5·59*
δ Aquilæ	3·74	3·75	35 Aquilæ	6·00	5·77*

* From Revised Harvard Photometry, with Colour Index applied.